

2

SAFETY

2. SAFETY

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2. SAFETY

2.1 ELECTRICAL HAZARDS

High voltages (up to 15kV) are used in this laser system. The laser should **NEVER BE OPERATED WITH EITHER THE LID REMOVED FROM THE LASER HEAD OR WITH ANY OF THE PANELS REMOVED FROM THE POWER SUPPLY UNIT**. Microswitches have been incorporated in the laser head and power supply unit to minimise the risk of electrocution from high voltage components in the laser. These interlocks should not be overridden.

If it is necessary to remove any of the panels, to clean optics or change the pump oil for example, **FIRST REMOVE THE SYSTEM KEY FROM THE SYSTEM KEY SWITCH AND SWITCH OFF THE POWER SUPPLY AT THE SOCKET. DO NOT UNPLUG THE POWER SUPPLY LEAD FROM ITS SOCKET** since this would disconnect the unit from a solid earth. Although under normal operation the electrical circuit is designed to discharge high voltage capacitors as soon as the HV power is switched off (via an HV dump switch), certain very rare failure modes could result in various capacitors remaining fully charged. If any of the interlocked panels are removed, all components within reach should be **EARTHED** with a suitable earthing stick before working on the apparatus.

**WARNING:
TREAT HIGH VOLTAGES WITH GREAT RESPECT
- THEY CAN BE LETHAL**

2.2 THERMAL HAZARDS

Copper Vapour Lasers require temperatures in excess of 1500°C to be produced within the laser discharge tube for laser operation. Because of this the laser mirrors, windows, end flanges and vacuum envelope reach temperatures high enough to cause burns even up to an hour after the laser has been switched off. In the case of a failure of the cooling fans on the laser head or power supply, other components may also reach hazardous temperatures and the time taken for these components to cool to room temperature will be significantly longer than normal. Users are therefore advised to **TAKE EXTREME CARE** when handling components which can only be reached by removing panels or other access ports.

2.3 MECHANICAL HAZARDS

Under normal circumstances, the vacuum vessel inside the laser head which contains the laser discharge tube presents little or no mechanical hazard. In the event of severe over-pressurisation of this vessel, however, it is conceivable that the vessel might fracture. Care should be taken to ensure that the pressure inside the vacuum vessel never exceeds 1200 mbar absolute. This pressure is set by the internal gas supply regulator which is factory preset and should on no account be altered by the user. The lid of the laser head case provides some protection against this unlikely failure mode.

2.4 LASER RADIATION HAZARDS

The laser is a very special light source which is quite different from conventional light sources. The safe use of a laser depends on the user becoming familiar with these differences and treating the instrument accordingly. The high energy output of the beam passing directly into the eye can cause serious damage with possible loss of vision. The beam might also cause damage to the eyes if it is directed into the eye even only by stray reflections from rough surfaces. Light sensitive equipment (e.g. photodiodes) can be damaged by direct or indirect exposure to the laser beam from some distance. Under certain modes of operation, the focused beam may have sufficient energy density to vaporise metal. For these reasons, the user is advised to follow the precautions detailed below:

- (1) Do not use the laser in the presence of flammable substances or explosives: these include volatile substances such as alcohol, petrol, solvents and ether. Flammable materials should be kept away from the laser to reduce the risk of fire.
- (2) Limit access to the laser to authorised users only. Keep inexperienced and untrained personnel away from the equipment.
- (3) Never look directly down the laser tube when the laser is hot or at scattered laser light from any surface. If it is necessary to use tools in the region of the beam, ensure that metallic parts are matt black and not chrome.
- (4) Avoid all direct exposure to laser light. The intensity of the beam could cause flesh burns or ignite clothing.
- (5) Set up the laser below eye level, and keep all beams below eye level to avoid inadvertent exposure.
- (6) As a precaution against accidental exposure to the output beam or its reflection, laser users should use safety glasses as required.
- (7) Place warning signs in the area of the laser beam to alert those present.
- (8) Use the laser in an enclosed room with a sign on the door clearly stating that a laser is in use. Laser light is well collimated and therefore presents a potential hazard over large distances.
- (9) Advise all those using the laser of these precautions: keep others away.
- (10) Make sure that you are familiar with and comply with all local laser safety regulations. Consult the authorised laser safety officer in your establishment before bringing the laser into service.
- (11) It is the responsibility of users of the laser system to ensure that the laser safety glasses they use provide adequate protection against eye damage from the laser. Laser safety glasses can present a hazard as well as a benefit: while they protect the eye from potentially damaging exposure, some also reject the laser beam completely, so the user cannot see it. Consequently, the operator may be unwittingly exposed to the beam.

2.5 DHHS/BRH COMPLIANCIES

The CU10-A and CU15-A lasers are Class IV laser products.

Note: Warning labels are used on all Oxford Lasers Metal Vapour Lasers. However, the labels on models sold in the USA will differ from those on models sold in the United Kingdom.

The following features incorporated in the instrument give conformity to United States Government requirements 21 CFR sub-chapter J, as administered by the Department of Health and Human Services (DHHS):

- (1) **KEY CONTROL:** The instrument cannot be turned on until the KEY SWITCH has been activated. Its operation and function are described in Section 4.1. The instrument cannot be operated unless the key is in place in the locked switch. In addition to these requirements, an EMERGENCY STOP SWITCH is fitted to the front of the power supply unit (PSU). This switch cuts all power to the unit beyond the contactor relay.

- (2) **LASER RADIATION EMISSION INDICATOR:** The appropriately labelled indicators on both the PSU and the laser head will light as soon as the power supply is connected. Laser emission is not possible unless the power supply is connected. The indicators are described in Section 4.1. White lights are used to ensure that they are always visible regardless of the type of safety glasses worn.
- (3) **PROTECTIVE HOUSING:** The laser beam path is enclosed by covers inside the laser head case. The case lid must be removed to reach the beam path covers. The beam path covers form the protective housing which prevents human access to radiation in excess of the limits of Class I as specified in the Federal Register, July 31, 1975, part II, Section 1040.10 (f) (1) and Table 1-A.
- (4) **WARNING LABELS:** On the laser head case, at the opposite end to that from which laser output occurs, is a Class IV warning label. The label shown in Figure 2.1 applies to the copper vapour lasers (CU10-A and CU15-A). That shown in Figure 2.2 applies to the gold vapour laser (AU2-A).

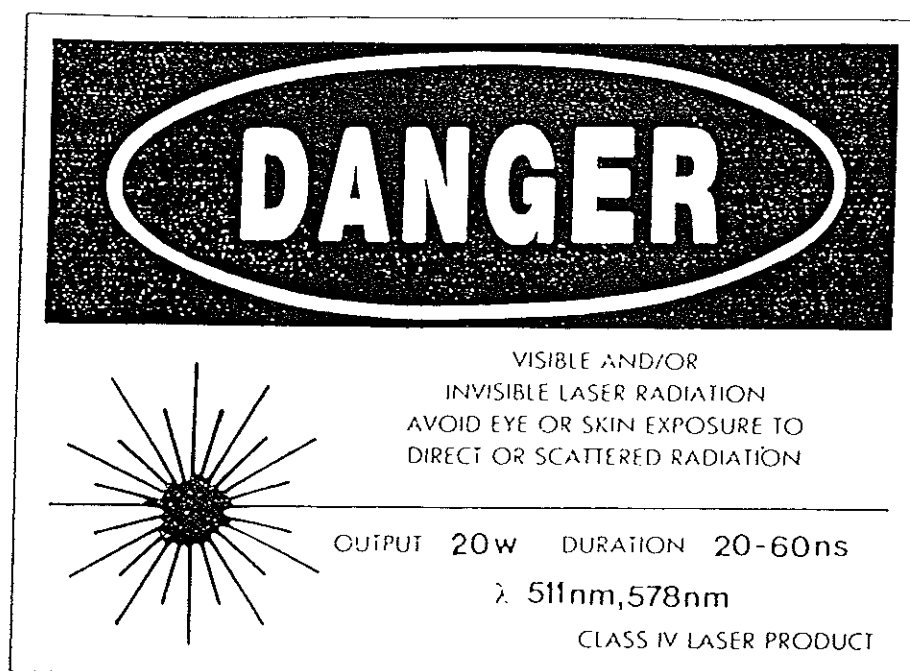


Figure 2.1 Models CU10-A and CU15-A warning label (USA)

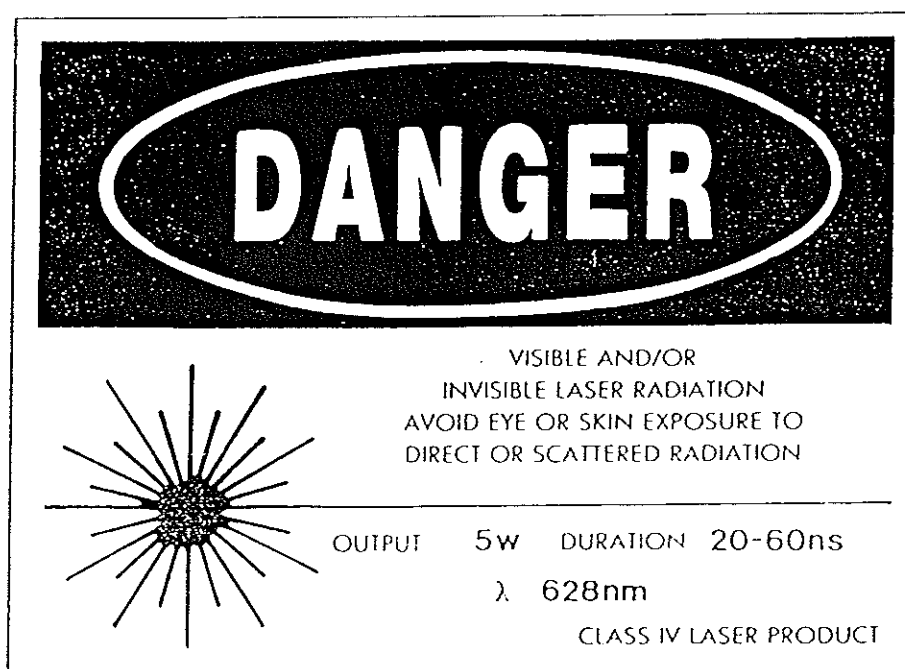


Figure 2.2 Model AU2-A Warning Label (USA)

- (5) **MAXIMUM RADIANT POWER:** The maximum average laser power, as indicated on these labels, is 20 Watts for a copper vapour laser and 5 Watts for a gold vapour laser in their standard forms. These lasers are always pulsed. The pulse duration is dependent on the pulse repetition frequency, and can have values between 5 nanoseconds and 60 nanoseconds FWHM (Full Width at Half Maximum height). The maximum single pulse energy obtainable from either laser is 5mJ. The pulse repetition frequency cannot normally be varied outside the range 1 Hz to 20 kHz. Standard configuration allows operation only in the frequency ranges given below:

	CU10-A	CU15-A
Standard Frequency Range	8-14kHz	9-13kHz

- (6) **APERTURE LABEL:** Affixed to the face of the laser head housing, above the laser output aperture, is the label shown in Figure 2.3.

**AVOID EXPOSURE
VISIBLE AND/OR
INVISIBLE LASER RADIATION
IS EMITTED FROM THIS APERTURE**

Figure 2.3 Laser aperture label (USA)

- (7) **CERTIFICATION LABEL:** The certification label shown in Figure 2.4 is affixed to the side of the power supply unit near the service ports.

CERTIFICATION
OXFORD LASERS CERTIFIES THAT THIS LASER
CONFORMS TO THE PROVISIONS OF THE UNITED
STATES DEPT. OF HEALTH AND HUMAN SERVICES,
BUREAU OF RADIOLOGICAL HEALTH,
REGULATIONS 21 CFR 1040.10 & 1040.11
RELATING TO ENFORCEMENT OF THE RADIATION
CONTROL HEALTH & SAFETY ACT OF 1968

Figure 2.4 Certification label (USA)

- (8) **BEAM PATH COVER LABEL:** The label shown in Figure 2.5 is affixed to the main support rail on each side of the laser head case.

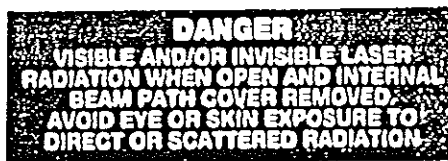


Figure 2.5 Beam path cover label (USA)

- (9) **MANUFACTURER'S LABEL:** The manufacturer's label shown in Figure 2.6 is affixed to the rear panel of the power supply unit, in the lower right hand corner.

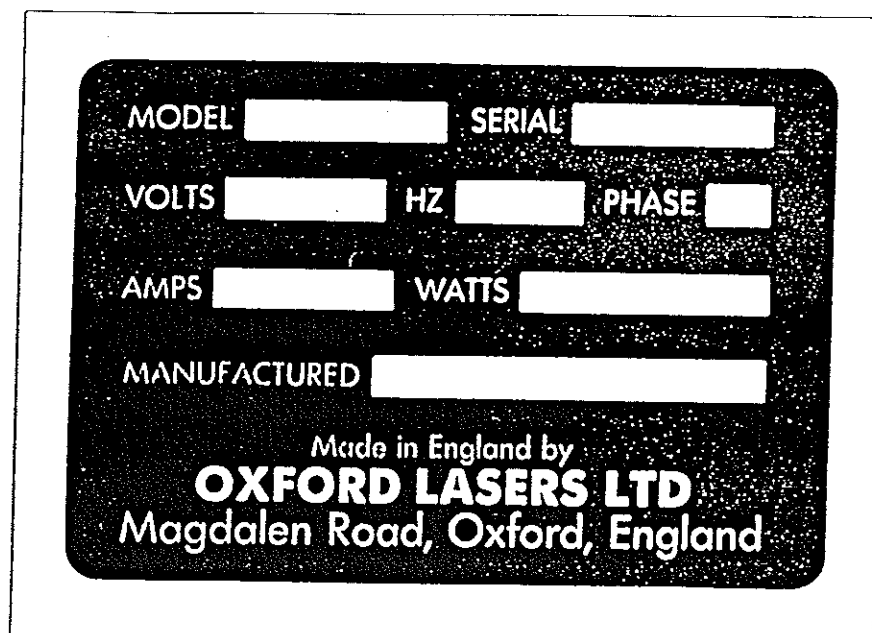


Figure 2.6 Manufacturer's label (USA)

- (10) **LASER COVER INTERLOCKS:** When the lid of the laser head case is removed, the interlocks at each end of the laser head turn the laser off. Their sole purpose is to protect the operator from high voltage shock. Exposure to laser radiation can only occur if the internal beam path covers are also removed. Access panels on the power supply are also equipped with interlocks for the protection of the operator.

- (11) **BEAM SHUTTER:** The beam shutter completely blocks the laser beam when closed, and prevents exposure. The beam shutter is mechanical and is designed to be a permanent fixture. Opening the shutter will release the full power of the laser beam and precautions against exposure must be taken.
- (12) **EXTERNAL INTERLOCK CONNECTOR:** An external interlock connector is situated on the rear panel of the power supply unit. This interlock consists of a receptacle and plug such that the laser turns off when the plug is removed. This connector is described in Section 4.1. Remote interlocking is provided by wiring a switch into the circuit via this plug.
- (13) **CONTROLS AND ADJUSTMENTS:** System controls on the power supply unit and laser head are described, with an explanation of their functions, in Section 4.1.

WARNING:

**USE OF CONTROLS OR ADJUSTMENTS OR PERFORMANCE OF PROCEDURES
OTHER THAN THOSE SPECIFIED HEREIN MAY RESULT
IN HAZARDOUS RADIATION EXPOSURE.**

- (14) **AVOIDANCE OF UNNECESSARY EXPOSURE:** With the beam shutter closed, the cover in place and fastened, the risk of exposure to radiation is within the limits of Class I. Operation with the case lid removed and the interlocks defeated should be allowed **ONLY** when necessary for service by experienced personnel. After servicing has been performed, turn the unit off, then replace the beam path covers and case lid before resuming normal laser operation.

2.6 BRITISH STANDARD CONFORMITY

2.6.1 Compliance with British Standard BS 4803

The CU10-A and CU15-A lasers conform to the British Standard (BS) 4803 on laser safety. The following warning labels and stickers are used on models sold in the United Kingdom and Europe.

- (1) **CLASS 4 LASER PRODUCT LABEL:** On the laser head case, at the opposite end to that from which laser output occurs, is a Class 4 warning label, as shown in Figure 2.7.

Class 4 Laser Product		
Laser Radiation Visible and / or Invisible		
Laser Medium :	Copper	Gold
Wavelengths (nm)*	511,578	312,628
Average Power (watts)*	15	3
Pulse Energy (mJ)*	2	0.5
Pulse Duration (nS)	10-30	10-30
MAX VALUES		

Figure 2.7 Class 4 laser product label (UK)

- (2) **APERTURE LABELS:** On the face of the laser head housing, to the right of the laser output aperture, the labels shown in Figure 2.8 are affixed.

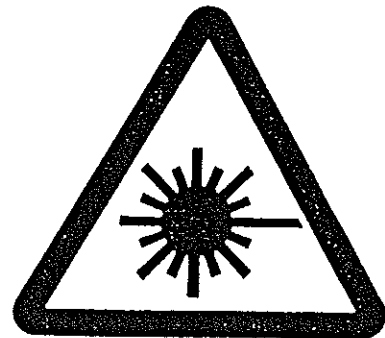
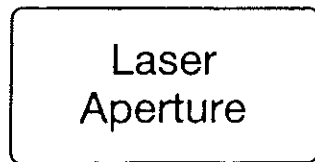


Figure 2.8 Laser aperture labels (UK)

- (3) **RADIATION WARNING LABELS:** The labels shown in Figure 2.9 are affixed to the laser head case, on the same side as the cooling fans, at the laser output end.

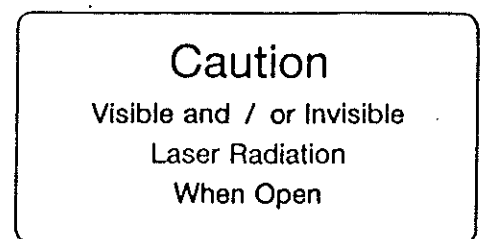
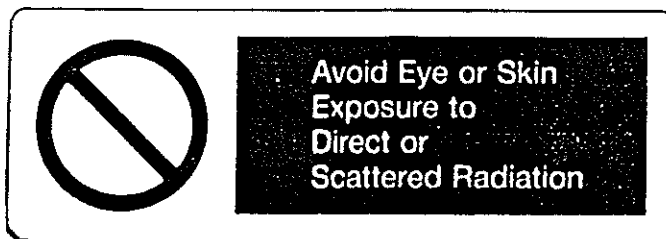


Figure 2.9 Laser radiation warning labels (UK)

- 4) **BEAM SHUTTER LABEL:** The label shown in Figure 2.10 is affixed to the Beam Shutter.
-



Figure 2.10 Beam shutter label (UK)

- 5) **MANUFACTURER'S LABEL:** The manufacturer's label shown in Figure 2.11 is affixed to the rear panel of the power supply unit, in the lower right hand corner.
-

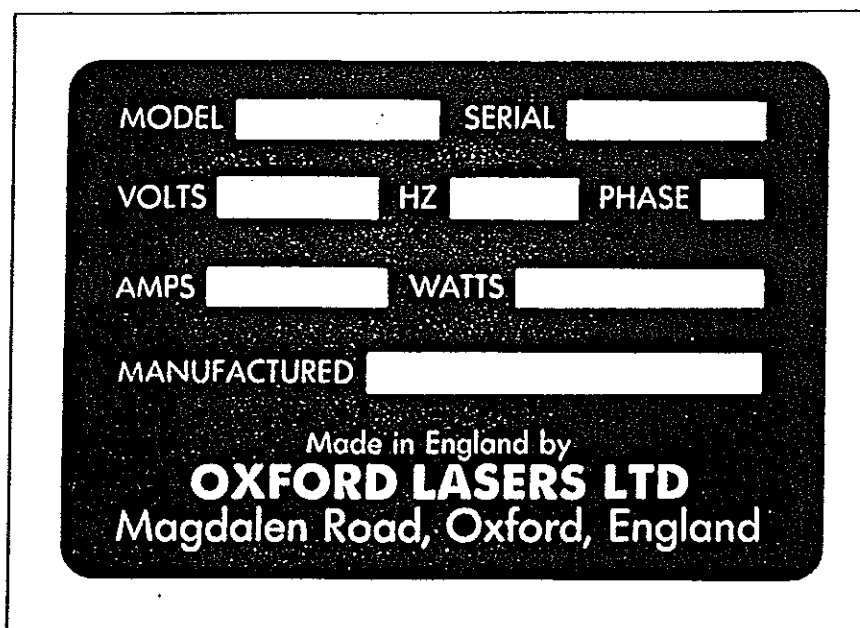


Figure 2.11 Manufacturer's label (UK)

- (6) **EXTENDED BOX LABEL:** The label shown in Figure 2.12 is affixed to the side rail of the laser immediately below the side of the acrylic cover used on extended box versions of these lasers.

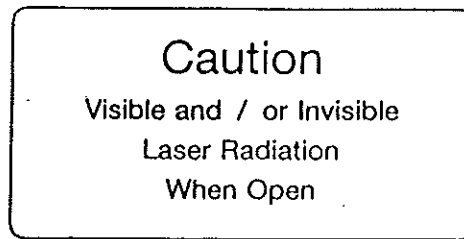


Figure 2.12 Extended box label (UK)

2.6.2 Compliance with British Standard BS 5724 PART 1

- (1) **HANDLING OF EQUIPMENT. EXTREME CARE** should be taken to ensure that the umbilical connection between the laser head and the power supply unit (PSU) does not become twisted.

The PSU is fitted with castors at each corner and there are locking brakes on the front two castors. The laser can be moved by placing the laser head on top of the PSU, such that the output end of the laser head faces the same way as the front panel of the PSU. It is best to put some protective material on the PSU to prevent the paintwork from becoming scratched. At least two people will be needed to give extra support to the laser head while the PSU is pushed on its castors.

If it is necessary to lift the PSU, the laser head should be supported separately. Suitable lifting platforms should be used to move the PSU. Care should be taken to keep the PSU within 10 degrees of the horizontal, to prevent oil spillage from the thyatron tank.

- (2) **POSITIONING OF EQUIPMENT.** The PSU should never be moved or positioned at an angle greater than 10 degrees from the horizontal, as there is the danger of oil spillage from the thyatron tank, and/or damage to the vacuum pump.

The laser head should be placed in a horizontal position to prevent the molten copper or gold charge from moving during operation. Adjustable feet are provided on the laser head to enable the equipment to be levelled.

Both the PSU and the laser head should be positioned such that all inlet and outlet fans are free from obstruction. A space of at least 40 cm is required for free air circulation.

- (3) **OPERATING CONDITIONS**

- (i) This equipment is not anaesthetic proof (neither AP nor APG) and is not intended for use within an Enclosed Medical Gas System.
- (ii) The equipment is not drip proof, splash proof, or water tight.
- (iii) The laser should only be operated in surroundings with an ambient temperature in the range 5 to 30 degrees centigrade.

- (4) **DETAILS OF BATTERIES AND SIGNAL INPUTS AND OUTPUTS.** The laser contains one sealed lead acid battery to operate the cooling fans when the system has been switched off. This battery is located on the low voltage side of the PSU, adjacent to the vacuum pump. The battery is a YUASA NP6-12 type: it has a 20 hour rate capacity of 6 Amp-hours, and connection is by 4.7mm tab terminals.

Details of the signal inputs and outputs are given below:

Input/Output	Maximum Voltage	Reference
SYNC OUT	15V	4.2.3 13
EXTERNAL input	20V	4.2.3 15
External remote interlock	24V	4.2.3 29